

DEPARTMENT OF PHYSICS & ASTRONOMY

PHYS - COIS 2250H: ELECTRONICS 2015WI

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Campus: Peterborough	Office Location: Science Complex 213	Office Hours: Wednesday 14:00 – 15:00, and by appointment
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1. Course Description

An applied course in the electronic circuits most commonly used in laboratory sciences. Circuit theory, test instruments, operational amplifiers, semiconductor theory, measurement sensors, power control, digital circuits, AC circuit theory, filters, DC power supplies, RC timing circuits, amplifiers, oscillators.

This is probably the most practical and technical of all of Trent's physics and astronomy courses. It has been designed so that a graduate of the course can build and understand much of the electronic circuitry needed in a typical research and development lab. By the end of the course you should feel comfortable wiring up circuits, know the operating characteristics of many analogue and digital components, and be able to design basic circuits.

Prerequisites: PHYS 1002H: *Introductory Physics II*
MATH 1100Y or 1101Y: *Calculus I*

2. Course Timetable

Type	Day	Time	Location
Lecture	Mondays	15:00-16:50	SC 317
Lecture	Wednesdays	16:00-16:50	SC 317
Labs	Thursdays	13:00-15:50	SC 317

The lab sessions will be led by Dave Marshall (dmarshall@trentu.ca, SC 319, x7461)

3. Required Text and Course Materials

A complete set of printed notes will be provided so there is no required text. Reference books:

R. J. Smith and R. C. Dorf, *Circuits, Devices and Systems*, 5th edition, Wiley

B. Grob, *Basic Electronics*, 8th edition, McGraw-Hill

J. J. Brophy, *Basic Electronics for Scientists*, McGraw-Hill

Diefenderfer and Holton, *Principles of Electronic Instrumentation*, Saunders

P. Horowitz and W. Hill, *The Art of Electronics*, 2nd edition, Cambridge

Course webpage for updates and additional information:

<http://www.trentu.ca/physics/rshiell/PHYS2250Hdir/PHYS2250H.html>

4. Learning Outcomes

Upon successful completion of this course, a student should:

- have an understanding of current, voltage, resistance, and Ohm’s law
- be able to analyze many-loop DC circuits using Kirchhoff’s laws, loop currents
- appreciate the working of multimeters and oscilloscopes
- understand the physical principles behind, and operation of, capacitors and inductors, and circuits containing capacitors and inductors
- be knowledgeable of voltage and current sources, Thevenin’s and Norton’s theorems.
- analyze circuits containing operational amplifiers
- understand semiconductor theory, the p-n junction and diode operation
- be knowledgeable about bipolar junction transistors: transistor characteristics, transistor switches, and thyristors
- have a good understanding of relays, and transducers and servo controllers
- analyze digital electronics: gates, memory and counters: Truth tables, DeMorgan’s theorems, SR flip-flop, JK flip-flop, Counters,
- the ability to analyze AC Circuits using complex representations. Impedance, RC filters, decibels, tuned filters
- understand transformers, rectification, capacitor filters, Zener regulators and IC Regulators
- appreciate the physics underpinning regenerative oscillators and quartz crystal oscillators

5. Course Evaluation

Type of Assessment	Weighting	When
In-class quizzes	5%	~bi-weekly
Assignments	15%	~bi-weekly
Laboratory	30%	~ weekly
Midterm test	15%	Monday Feb 9
Final Exam	10% (lab component) 25% (written)	Thursday Mar 23 April exam period

The in-class quizzes include short questions based on the readings. The assignments comprise a variety of problems, with a small amount of programming required (typically in Excel or MatLab). The midterm and final exam will typically contain a mix of short- and long-answer questions.

Note: Regardless of the overall grade calculated above, an average of at least 40% on the test and final exam, weighted as above, must be obtained in order to pass this course. Otherwise a maximum grade of 45% (i.e. an F) will be assigned.

Late policy: assignments that are late without a good reason provided in advance of their respective deadline will be subject to a 10% reduction in marks for each two working-day period.

6. Class Format and Ordering of Topics

Readings will be assigned from printed notes prior to each ‘lecture’ period, and there will be regular quizzes at the start of classes. This set of notes is required, and is available from me for \$10.00. Much of the class time will be spent in small-group discussion to develop a conceptual understanding of the material. The material will be closely connected to the laboratory sessions. I am available outside these formal teaching hours for consultation. Take-home assignments requiring more in-depth quantitative analysis will be submitted for marking.

By the end of the course we shall have covered a substantial part of the material from both the *Circuits* and the *Electronics* sections of Smith and Dorf.

The course notes have the following headings:

1. Review of electricity
2. DC circuit theory
3. Multimeters and oscilloscopes
4. Capacitors and inductors
5. Network theorems
6. Operational amplifiers
7. Semiconductors and the p-n junction
8. Use of diodes for wave shaping
9. Bipolar junction transistors
10. Power control
11. Transducers & servo controllers
12. Digital electronics: gates, memory and counters
13. AC circuits
14. DC power supplies and voltage regulation
15. Oscillators

Lab Schedule: There are 12 weeks of instruction comprising labs each week except during week 0 (Thursday Jan 8). The lab component of the final exam will occur during a lab session towards the end of the course. Lab write-ups are relatively simple, and submitted on pre-formatted, printed sheets. Labs cover the following:

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| 1. DC measurement and resistance | Jan 15 |
| 2. The oscilloscope and periodic waveforms | Jan 22 |
| 3. Operational amplifiers | Jan 29 |
| 4. Power control | Feb 5 |
| 5. Transducers and servo systems | Feb 12 |
| READING WEEK | |
| 6. Logic gates and digital circuits | Feb 26 |
| 7. Computer Interfacing | Mar 5 |
| 8. Filters | Mar 12 |
| 9. DC Power Supplies | Mar 19 |
| 10. Lab component of final exam | Mar 26 |
| 11. Oscillators | Apr 2 |

University Policies

1. Academic Integrity

Academic dishonesty, which includes plagiarism and cheating, is an extremely serious academic offence and carries penalties varying from failure on an assignment to expulsion from the University. Definitions, penalties, and procedures for dealing with plagiarism and cheating are set out in Trent University's Academic Integrity Policy. You have a responsibility to educate yourself – unfamiliarity with the policy is not an excuse. You are strongly encouraged to visit Trent's Academic Integrity website to learn more: www.trentu.ca/academicintegrity.

2. Access to Instruction

It is Trent University's intent to create an inclusive learning environment. If a student has a disability and/or health consideration and feels that he/she may need accommodations to succeed in this course, the student should contact the Student Accessibility Services Office (SAS), (BH Suite 132, 705-748-1281 or email accessibilityservices@trentu.ca). For Trent University - Oshawa Student Accessibility Services Office contact 905-435-5102 ext. 5024 or email nancyhempel@trentu.ca. Complete text can be found under Access to Instruction in the Academic Calendar.